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Technical Association of Pulp and Paper Industry
Standard Method T 803 m-50

Standard Methods of Test for

PUNCTURE AND STIFFNESS OF PAPERBOARD, CORRUGATED AND SOLID FIBERBOARD[1]

This Standard is issued under the fixed designation D 781; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

1. Scope

1.1 These methods cover the determination of puncture and stiffness of paperboard and corrugated and solid fiberboard.

1.2 The methods appear in the following order:

	Sections
Puncture Test	2 to 7
Stiffness Test	8 to 12

PUNCTURE TEST

2. Significance

2.1 The puncture test (also known as the Beach or G. E. Puncture test) measures the resistance of board in either single sheets (that is, components) or in combined form to puncture. Such puncture may result from contact with solid objects such as a corner of a box, or the like. The unit measured by the instrument is the energy required to puncture the containerboard in the designated manner (one unit equals 0.265 in·lb (0.305 cm·kg)). These units are actually made up of several components, the principal ones being the energy required to tear the material and the energy required to bend it out of the way of the point. By conducting both puncture and stiffness tests (see Section 8) on the same lot of material, the relative contribution of the tearing and the stiffness may be evaluated.

2.2 The test evaluates in a composite fashion some fabrication factors and material values, although it is not possible to isolate the two specifically.

3. Apparatus (Fig. 1)

3.1 *Pendulum*, incorporating an arm in the form of an arc of 90 deg.

3.2 *Puncture Point*, affixed to the end of the arm and having the shape of a right angle triangular pyramid 1 in. (25 mm) in height with rounded leading edges of 0.062 ± 0.002-in. (1.57 ± 0.05-mm) radius. The point shall be honed to a 0.062-in. radius and base edges left sharp.

3.3 *Puncture Point Collar*, loose fitting around the base of the puncture point to avoid friction that would result if the punctured material rubbed against the puncture arm.

3.4 *Trigger or Latch*, to hold the pendulum in the horizontal position.

3.5 *Clamping Jaws*, spring-actuated, for holding the specimen to be tested.

3.6 *Pointer and Scale*, to indicate the arc through which the pendulum travels after penetrating through the specimen.

3.7 *Weights*, which when attached, give a maximum scale value of at least 1300 units of energy when the pendulum is in the horizontal position, and scale graduations to correspond to the weights used.

NOTE—Modified machines having greater range are available.

3.8 *Loose Plate*, inserted between the clamping jaws for the purpose of defining the test area. Means shall be provided for securing the removable plate once it has been properly positioned (see 4.1.7). The loose plate shall be removed when checking the zero reading of the apparatus.

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[1] These methods are under the jurisdiction of ASTM Committee D-6 on Paper and Paper Products.
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3.9 *Adjustable Screws*, bearing against the pointer assembly during the measuring half of the pendulum swing, permitting adjustment of the full-scale position of the pointer.

3.10 *Release Attachments*—For testing lighter materials, the apparatus can be supplied with an attachment that allows the release of the pendulum at a 45-deg angle. An auxiliary low scale is also supplied which, when attached to the standard scale plate, provides additional calibration from 0 to 30 and allows reading to half a unit.

4. Adjustment of Apparatus

4.1 Install the apparatus on a rigid, heavy foundation of convenient height, bolt it in place, and level it in both horizontal directions. To eliminate the influence of extraneous movement during the swing of the pendulum, the mount should be a separate concrete base. Make adjustments of the apparatus with the entire clamping assembly unbolted and swung on a hinge away from the path of the pendulum. On older instruments the assembly must be removed completely from the machine.

4.1.1 *Pendulum Friction*—Remove the weights and weight support stud, put the puncture point collar in place on the point, rotate the pointer to a position below the zero mark, and then latch and release the pendulum. The pendulum should swing for a minimum of 8 min before coming to rest.

4.1.2 *Zero Reading*—To check zero, remove the weights and weight support stud; fix the puncture point collar on the base of the puncture point. Allow the pendulum to hang vertically on the pivot shaft (with base leveled). Then with the adjusting screw, align the pointer exactly on full scale. With the pointer set to about 1 in. (25 mm) above zero on the scale, raise the pendulum until the latch engages. Release the pendulum. If the scale reading is not zero, loosen the four set screws that position the latch tongue vertically and raise or lower the latch tongue as required. Repeat this procedure until the scale reading is zero.

4.1.3 *Pointer Friction*—Test for pointer friction by latching the bare pendulum without weights or weight stud, with the collar attached to the puncture head, remove the clamping plate, rotate the pointer to full-scale reading, release the pendulum, and note the position of the pointer at maximum travel. Then without moving the pointer, relatch the pendulum, release it, and allow it to swing and push the pointer farther. Adjust the pointer friction by means of the screw in the stud projecting from the pointer hub so that this additional movement is not more than two units. Recheck the friction with the pointer at midscale to guard against reducing the fraction too much. The pointer will move or "bounce" below the position indicated in the second step if friction is too low.

4.1.4 *Puncture Point Collar Adjustment*—Place the collar on the base of the puncture point in the same position each time. A dot of paint on one side of the collar to match a dot on the point base is an easy way to assure that this is accomplished. An adjustable pin determines the force needed to dislodge the collar. This force shall be more than 3, but less than 4 oz (100 ± 15 g) of pull when the collar is in a horizontal position. The puncture point shall extend at least 0.015 in. (0.38 mm) beyond the outer edge of the collar when the collar is attached to the puncture point. The flange angle shall be kept at approximately 135 deg.

4.1.5 *Clamping Pressure*—The clamping pressure between the specimen clamps should be sufficient to keep the clamps open ¼ in. (6.4 mm) when 55 ± 5 lbf (245 ± 22 N) is applied downward from the middle of the lower plate. Should adjustment be necessary, the wing units at the bottom of the spring tube may be tightened or loosened. The clamp load should be uniformly distributed over the test specimen. Strips of the thinnest specimen to be tested may be placed between the jaws at various points. If any can be removed easily, the jaw alignment should be changed until the load is uniform.

4.1.6 *Center of Gravity*—If the center of gravity of the pendulum does not lie in the proper plane, additional or auxiliary weights will shift the pointer zero and will necessitate changing both the pointer and the latch adjustments when changing scales. The alignment of the center of gravity may be most conveniently checked by removing the weights and stud from the pendulum, allowing the pendulum to come to its rest position (with the collar attached to the puncture point), and gently rotating the pointer clockwise until it just touches the pointer adjusting screw. Do not move the pendulum when in contact with the screw. Note the pointer position, attach the stud and weights to the pendulum, and repeat the above operations. If the center of gravity lies in the proper plane, no shift of the pointer will occur. If the pointer shifts, the center of gravity is incorrect. The balancing weight is adjusted at the factory and then staked in place. It should never be moved unless it is certain that the center of gravity is incorrect. If adjustment is indicated, it is well to check the pendulum with all combinations of weights and by rotating the weights to make sure the weights are concentric before returning the pendulum to the factory for adjustment.

4.1.7 *Loose Plate*—Secure the loose plate beneath the upper clamping jaw in such a manner that a vertical projection of the lower edges of the puncture point is equidistant from the triangular edges of the loose plate opening when the base of the puncture head is 1.25 in. (31.8 mm) below the upper clamping jaw.

4.1.8 *Puncture Point*—The three corners at the base of the puncture point shall be equidistant (within ±1⁄16 in. (1.6 mm)) below the upper clamping jaw when the base of the puncture point is 1.25 in. below the upper clamping jaw. The apex of the puncture point shall not deviate from a plane equidistant from the pendulum bearings by more than 0.06 in. (1.5 mm). That edge of the puncture point base farthest from the axis of rotation shall be parallel to the axis of rotation. The puncture point is an important part of the apparatus and must be protected from abuse and damage. It should be free of nicks, scratches, and have a smooth surface. Clean the point with a degreasing agent such as carbon tetrachloride when tests are made on wax-coated, asphalt-laminated, or other specially treated boards which may cause an accumulation of foreign substance on the surface of the puncture point. When tests are made on such boards, clean the point after each puncture.

5. Test Specimens

5.1 Select the test specimens in such a manner that they accurately represent the sample of material to be tested. Each specimen shall be of sufficient size that no slippage occurs between it and the clamping jaws of the apparatus. No part of the test area shall be closer than 1½ in. (38 mm) to any edge, scoreline, or imperfection in the board. For multiwall corrugated board, specimens should be at least 10 by 10 in. (254 by 254 mm) with no tests made closer than 3¾ in. (95 mm) from the edges, scoreline, or imperfections in the board.

6. Conditioning

6.1 Condition the specimens before testing in accordance with ASTM Method D 641, Conditioning Paperboard, Fiberboard, and Paperboard Containers for Testing,[2] and conduct the tests in the same atmospheric conditions.

7. Procedure

7.1 Check the zero reading in accordance with 4.1.2 for each group of tests.

7.2 Place the test specimen between the clamping jaws. Before making each puncture, place the puncture point collar on the base of the puncture point and set the pointer about 1 in. (25 mm) above the expected reading. Raise the pendulum to the horizontal position and latch it. Release the pendulum by pushing the latch handle to the left. Note the reading on the proper scale after the pendulum has completed its swing. This reading should be made to the nearest one half division of the scale used. It is not advisable to make tests giving readings within the upper or lower 25% of the scale. Select the scale and corresponding weight so that readings will fall as close to the center of the scale as possible. The weights to be used for each scale are indicated on the scale plate of the apparatus. Follow the same procedure for testing light-weight material, but use the bare pendulum without additional weight or stud, release the pendulum from the 45-deg position, and use the auxiliary low scale.

7.3 Make four punctures, which comprise a set. One set shall constitute one test. The plane of the curved pendulum arm shall be used as the reference in relating the position of the specimens to the testing machine. Directions refer to the direction of the corrugations of corrugated board or grain direction of uncombined sheets or solid fiber. The orientation of the specimens for a set shall be as follows:

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[2] *1974 Annual Book of ASTM Standards*, Part 20.

7.3.1 Parallel, with one surface down,

7.3.2 Parallel, with the other surface down,

7.3.3 Perpendicular, with one surface down, and

7.3.4 Perpendicular, with the other surface down.

7.3.5 On uncombined board or single face corrugated, make all tests with the smooth surface down.

7.4 The procedure for testing lightweight material, using the auxiliary low scale (see 3.10), is the same as for testing any other material on the regular scale. Note, however, that the readings are made on the auxiliary scale attached to the scale plate. The bare pendulum is used without additional weight or stud and the pendulum is released from the 45-deg position.

STIFFNESS TEST

8. Significance

8.1 The stiffness test is a measure of the energy required to force a puncture point of designated size and shape completely through a sample of fiberboard when the board is prepared to receive the puncture point by slitting in the prescribed manner. The measured value is largely dependent upon the stiffness of the board since no tearing is involved.

9. Apparatus

9.1 The apparatus shall be the same as described in Section 3, with the addition of the following:

9.1.1 *Template*, containing three slits 2½ in. (64 mm) in length, meeting at one point and so spaced angularly that they coincide with the edges of the puncture point as it passes through the specimen.

9.1.2 *Sharp Knife.*

10. Test Specimens

10.1 Test specimens shall conform with the requirements prescribed in Section 5. They shall be further prepared by precutting for stiffness test as follows: Locate and define the cuts in the specimens by using the template (9.1.1). Two orientations shall comprise a set. One set shall constitute one test. The plane of the curved pendulum arm shall be used as the reference in relating the position of the specimens to the testing machine. Directions refer to the direction of the corrugations of corrugated board or grain direction of uncombined sheets or solid fiber. The orientation of the specimens for a set shall be as follows:

10.1.1 Parallel, and

10.1.2 Perpendicular.

10.2 Lay the template on the inner facing, according to the above orientations, and trace the slits of the template with a pencil. Remove the template and with a sharp knife cut the lines defined by the pencil tracing. Completely cut these three lines through, making certain that their ends are perpendicular to the surface of the board, and that they meet completely at the midpoint.

11. Conditioning

11.1 The specimens shall be conditioned in accordance with Section 6.

12. Procedure

12.1 Check the zero reading in accordance with 4.1.2 for each group of tests. Place and angularly orient the test specimens between the clamping jaws of the testing machine so that the point and the three edges of the puncture point will pass exactly through the prepared slits.

12.2 Select the scale and corresponding weight so that readings will fall as close to the center of the scale as possible (see 7.2).

12.3 Make all tests from the outside liner of the corrugated board and from the smooth side when testing uncombined board. Place the puncture point collar on the base of the puncture point before each test is made. (It is designed to prevent the puncture material from bearing against the puncture arm and thus cause an error due to friction.) Set the pointer about 1 in. (25 mm) higher than the position of the expected reading before each test is performed.

12.4 Record only readings in which the puncture point passes completely through the board. Read and record the values to the nearest one half division of the scale used.

13. Report

13.1 Report puncture tests results in units as shown on the scale. Report stiffness test results also in scale units.

13.2 The report for both puncture and stiffness tests shall include the following:

13.2.1 Room temperature and relative humidity,

13.2.2 Instrument scale used,

13.2.3 Number of tests made in each orientation,

13.2.4 Average results for tests made in each orientation,

13.2.5 Over-all average results, and

13.2.6 Maximum and minimum values obtained.

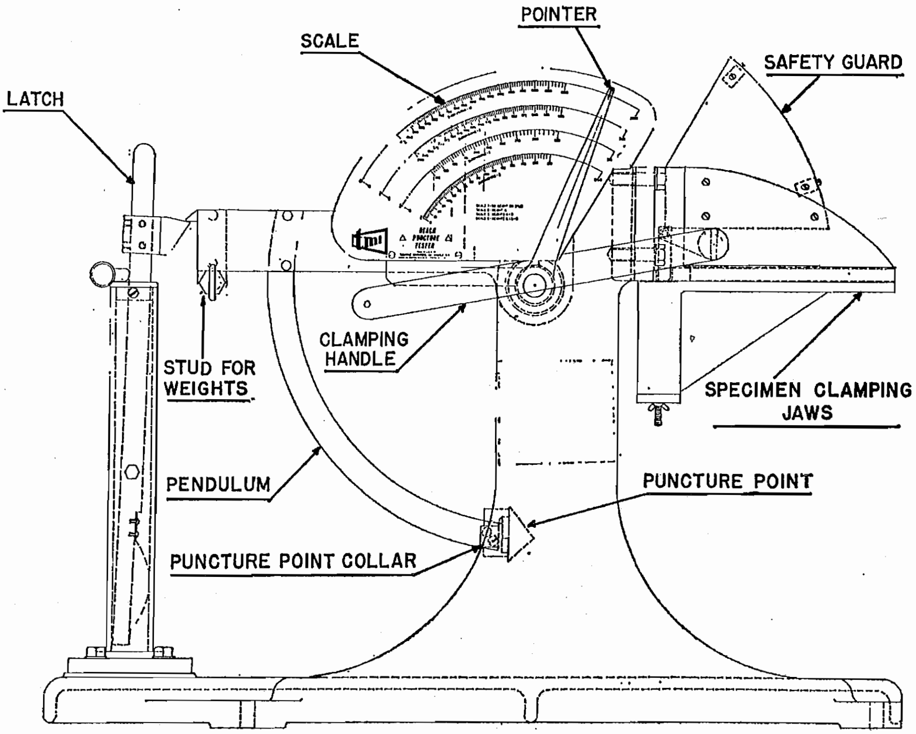

FIG. 1 Apparatus for Puncture Test.

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